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The Induced Affect Response: 10-Week-Old Infants' Responses to Three Emotion Expressions

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Responses to mothers' presentations of happy, sad, and angry faces were studied in a sample of 12 infants, 6 boys and 6 girls at age 10 weeks ± 5 days. Each infant's mother displayed noncontingent, practiced facial and vocal expressions of the three emotions. Each expression occurred four times, with a 20-s head-turn-away between presentations. The orders of presentation were randomly assigned within sex of infant. Mothers' and infants' facial behaviors were coded using the Maximally Discriminative Facial Movement Coding System. The data indicated that (a) the infants discriminated each emotion, (b) apparent matching responses may occur under some conditions but not all, and (c) these apparent matching responses were only a part of nonrandom behavior patterns indicating induced emotional or affective responses of infants to mothers' affective expressions.

When an infant responds to an emotion signal, to what does it respond and what is a response? The nature of the answer to this question is crucial in unraveling conflicting interpretations of the meaning of an emotion signal (Campos & Stenberg, 1981; Hoffman, 1978; Izard, 1977, 1979a; Lewis & Michalson, 1983).

Most empirical definitions of the emotion signal in studies of infants' responding to emotion signals are restricted to the visual channel (e.g., LaBarbera, Izard, Vietze, & Parisi, 1976; Nelson, Morse, & Leavitt, 1979; Sackett, 1966) or to the auditory channel (e.g., Sagi & Hoffman, 1976). Only in the study of depression, is the whole repertoire of face, voice, touch, and gesture allowed to be the signal (e.g., Tronick, Ricks, & Cohn, 1982). When the channel is only visual, most reports indicate that infants do not begin to respond differentially to emotion signals before 5 months (see Campos & Stenberg, 1981, or Oster, 1981, for review). When the neonatal distress cry is the auditory stimulus, the "empathic" response may be observed in a 2 to 3-day-old infant (Sagi & Hoffman, 1976). When both the voice and face are used in demonstrating depression, infants can respond differentially by at least 3 months of age (Tronick et al., 1982), perhaps earlier (Stern, 1977).

The problem of the infant's ability to respond emotionally to an emotion signal remains unanswered because there has not been an approach to the problem that considered the definition of the emotion in terms known better in perceptual development as the "affordance" of the emotion signal. The theory of affordances maintains that one perceives the value or meaning of an event prior to separate physical properties of the event or stimulus. "There is much evidence to show that the infant does not begin by first discriminating the qualities of objects and then learning the combinations of qualities that specify them. Phenomenal objects are *not* built up of qualities; it is the other way around. The affordance of an object is what the infant begins by noticing. The meaning is observed before the substance and surface, the color and form, are seen as such. An affordance is an invariant combination of variables, and one might guess that it is easier to perceive such an invariant unit than it is to perceive all the variables separately." (Gibson, 1979, pp. 134–135). As Campos and Stenberg (1981) noted, this concept is useful in comprehending the results of developmental studies of affect. Only the older child will have learned that part of an emotion signal may have the affordance of the whole emotion event. Nevertheless, the infant may respond quite early to a complete, contextual presentation of an emotion.

There are several responses that one could predict the infant would have to a complete emotion presentation, depending on theoretical orientation. One possible early (before 3 or 4 months) infant response to any emotional signal, positive or negative, would be smiling and gazing (e.g., Ahrens, 1954; Buhler & Hetzer, 1928; Spitz & Wolf, 1946). This prediction is made on the assumption that infants will smile and gaze at any face; they are unable to differentiate the affect signals. Another prediction states that the infant might smile and gaze at familiar signals, but initially be distressed at unfamiliar, or discrepant signals. This response, too, predicts that the infant's response is not specific to the meaning of an emotion, but only to its familiarity (e.g., Kagan, 1974; McCall & McGhee, 1977). A third position predicts that even an infant younger than 3 months might respond with an emotion that mirrored the emotion stimulus (e.g., Hoffman, 1978; Tomkins, 1962). This prediction is based on the assumption that the emotion presentation, itself, is a stimulus for the infant's emotion. For example, Tomkins (1962) wrote, "All affects . . . are specific activators

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of themselves—the principle of contagion. This is true whether the affect is initially a response of the self, or the response of the other." (p. 296). Finally, another approach predicts that the infant would respond in a manner that indicated differential self-regulation (Stern, 1985; Tronick et al., 1982). In this case, the infant's behavior in response to each emotion is differentially determined by each specific emotional expression but would not necessarily match or mirror the presentation. According to the hypotheses of self-regulation, the response additionally would indicate the infant's ability to cope with the emotion and might therefore change developmentally. Both of the last predictions rest on a theoretical position in which emotional expressions contain meaning and have affordances for the infant.

Our own predictions about an infant's ability to respond emotionally to an emotional stimulus are derived from differential emotions theory (Izard, 1977; 1979a; Tomkins, 1962); however, we have modified the theory to incorporate specific predictions based on the empirical studies and theoretical positions reviewed. We predicted that the model's expression of emotion could be a meaningful releasor or arouser of an emotional response from the infant. This response might have a self-regulating effect, but it would not be intentionally self-regulating. Whether or not the infant's response was similar to the emotion presented would depend on several factors including the infant's ability to express the emotion as adults express it (i.e., development of motor capacity for expression), the experiences that the infant has had with the person doing the display (i.e., familiarity vs. novelty), and the infant's prior motivational state. Repeated presentations of an emotion should induce a similar affective state, but not necessarily the exact facial match. For example, if the mother has been smiling at the infant and then switches to the angry expression abruptly, the infant's initial response should be interest or even a smile. At that point the infant is responding to a change in expression (Kagan, 1974; McCall & McGhee, 1977) but not to the angry expression itself. However, repeated presentations of the anger should cause fear, distress, or anger in the infant, although some infants may attempt to regulate or modulate the expression by gaze aversion or other methods. With continued presentation, there should be increasing likelihood of apparent matches, because the emotional display, itself, should induce the same emotion. In Tomkins' (1962) terms, it is contagious. In our opinion this is not a result of imitation but of induced affective state.

In consideration of these issues, it seems to us that a new approach to evaluating the central problem of determining the age at which infants react emotionally to emotion signals is needed. It has to satisfy several criteria. The emotion signal should be multi-modal, while still being as controlled as possible. It should be presented by an already familiar model so that all presentations are not relatively "unfamiliar" by definition. Finally, the range of possible reactions by the infant should be as broad as possible to allow each of the positions described above to be demonstrated, if any one of them is true.

Wanting to maximize the possibility that the infants would respond, while still demonstrating the possibility that our current estimates of the age limits for these responses are too high, we chose to use infants just under 3 months (10 weeks). This seems reasonable given Tronick et al.'s (1982) success. In order to compare the possible differentiation of responses, we had mothers present three emotions, two negative and one positive. To check for the effect of repeated presentation, we had the mother present the same emotion four times in a row. In order to make minute distinctions among the possible emotional responses, we used a second-by-second analysis of infant gaze direction and facial expression.

Method

Subjects

Nineteen full-term infants (11 boys and 8 girls) participated in the study procedure. They were 10 weeks old ± 5 days. Data from three subjects (2 boys and 1 girl) were incomplete due to equipment failure. Data from 4 infants (3 boys and 1 girl) were incomplete because the infants could not be soothed after the first anger presentation.

The final sample consisted of 6 boys and 6 girls. Nine of these were breast fed; 3 were first born, 8 second born and 1 was third born. Mothers were paid transportation costs.

Procedure

All testing was done in the afternoon at a time that mothers expected the infant to be alert and comfortable. When necessary, infants were changed or fed or slept before the presentations began. Upon arrival mothers had the procedure described to them and signed consent forms. One of the experimenters then gave instructions to the mother for her facial and vocal presentations. Each mother was shown examples of happy, sad, and angry facial expressions from Ekman and Friesen (1975). Appearance changes in brow, eye, and mouth regions were pointed out and demonstrated. Mothers were asked to practice, and mirrors were available to check accuracy. Additionally, it was suggested that they imagine happy, sad, or angry situations while demonstrating. Their voice was to match the facial expression of happy, sad, or angry. Mothers were instructed to speak continuously saying "You make me so happy (sad or mad)." They were not to say the baby's name, to raise or lower the voice dramatically, to touch the baby, or to turn except when instructed. The mother was told to start each expression while turned away, then turn to face the baby maintaining the expression and not reacting to the baby's responses.

Each mother presented four 15-s episodes of each of the three expressions, with a 20-s head-turn-away between presentations. One experimenter sat behind the mother to signal the correct expression and the time. She was behind and below the table on which the infant sat and therefore out of the infant's vision while visible to the mother when she turned away from the baby. One experimenter sat behind a curtain to the side in front of the mother and behind the baby to signal time and move cameras as needed. Order of expression presentation was randomly assigned so that every order occurred twice (for one girl and one boy). Total presentation time was 7 min. Mothers turned away for interpresentation intervals rather than presenting a nonexpressive face because the nonexpressive face is distressing to infants this age (Brazelton, Tronick, Adamson, Als, & Wise, 1975; Cohn & Tronick, 1981).

Coding

The babies' and mothers' facial expressions were coded separately with a slightly modified MAX (Maximally Discriminative Facial Movement Coding System; Izard, 1979b). Gaze direction was coded from the videotapes, and mother's vocal expression was coded from audiotapes that had emotion-specific words deleted. Only the repeated phrase, "I'm so . . ." was left on the tapes.

Facial Coding

Mothers and infants were coded separately. Their videotapes were available both separately and mixed on split screen. The split screen tape was used to confirm time sequences. The first 15 s of each presentation was coded second-by-second (a clock was displayed on the screen). Two highly trained coders coded all episodes; one coder knew the design of the study, but the other coder was naive to the purpose or design. The coding videotapes had mixed episodes of infants and affect presentations; they did not follow the order of testing.

The overall reliabilities were 88% for baby coding and 90% for mother coding. Reliabilities for brow, eye, and mouth regions were 91%, 86%, and 88%, respectively, for the babies and 79%, 94%, and 97%, respectively, for the mothers. A third coder resolved disagreements between the two original coders by examining those seconds that had different codes assigned.

After the different segments of the face were coded, the emotional expression was assigned using MAX coding rules and some combinatorial rules we added: (a) any blend of interest or of mouth "movements"—chewing or sucking—with another affect was coded as the other affect; (b) any clear mouth movement that occurred in the absence of movement in the upper part of the face determined the affect (e.g., corners down indicated "sad" when it alone occurred). These additional rules accounted for 5% of the babies' seconds and 10% of the mothers' seconds.

Gazing Coding

Because it was difficult to determine direction of gaze, we used head movement in conjunction with gaze to determine the direction of gaze. "Forward" means head and eyes face mother. "Down" means head is facing babies' feet. "Side" means face and eyes move away from the midline but not down. Intercoder reliability was 90%.

Vocal Ratings

Three naive-to-the-study coders classified mothers' tone of voice as "happy," "sad," or "angry." The tape had been edited to eliminate all emotion-specific words, and the distortion on the tapes resulting from editing limited the usefulness of these tapes. The reliabilities for all three coders combined was 63%. Across all three coders there was 89% agreement with mother's intent for happy, 79% for sad, and 59% for angry.

Criteria for Analyses

To clearly demonstrate that the behavior was a matching behavior or even that it had been modified and was not just a frequently occurring behavior, it was necessary to establish a laboratory baseline for all the expressive behaviors of the infant across all situations of the study. Thus, for example, if the mother's happy expression seemed to affect the expression of the infant, it would be checked by demonstrating that the infant's happy expression occurred significantly more whenever the mother smiled and decreased significantly when the mother did anything but smile. It could be that any expressive face would produce a smile; therefore, to control for that possibility some baseline for the smile behavior has to be established (see Jacobson, 1979; Meltzoff & Moore, 1977). The baseline for each behavior was its frequency across all conditions.

As an even more stringent requirement, we required infant behavior to change within a regular interval following the model's presentation. Because the model may change expression fairly rapidly we required that the infant's changing behavior be tied to the model's changing behavior; that is, in order to be "matching," for example, the infant must match the model within a second following the model's expression presentation. This particular control has not been applied previously but it can easily be done with event-lag analysis. This type of analysis is particularly useful in detecting any regularities in the behavior that represent a change from baseline (Sackett, 1979). The analysis could be used to indicate whether the infants' behavior varies as a function of their mothers' expressions, independent of whether the particular behavior is matched.

Results

The babies' responses to their mothers' presentations were analyzed using the event analysis technique developed by Sackett (1979) and amended by us (1982). In reviewing the MAX codes of the mothers' facial expressions, it was found that the mothers did not continuously display the expression that they were instructed to display. Therefore, this nonparametric test was chosen partly because it allowed an investigation of the babies' responses to the mothers' behavior each second rather than relying on gross estimates of mothers' affect.

Although mothers did not continuously display the most precise affect expression, their departures probably indicate differences in intensity rather than simple "error." Mothers seldom expressed joy or sadness during a time when they were supposed to demonstrate a different affect (less than 1% of the time) and expressed anger instead of sad only 6% of the time. When the mothers were expressing something other than the requested affect expression it was usually coded as interest or no-movement. Across all presentations three-quarters of the mothers showed some interest; all but one mother had no-movement seconds coded. Surprise was displayed briefly by one mother. One percent of the interest displays were supposed to be joy, 44% were supposed to be sadness, and 56% were supposed to be anger; 7% of the nonmovement displays were supposed to be joy, 52% were supposed to be sadness, and 42% were supposed to be anger. These results demonstrated the necessity of coding the models, because their behavior was variable even under these controlled conditions. They also demonstrate that continuous displays—with speech—of anger or sadness involve many seconds of no discernable facial movement.

Because the mothers displayed variable or blended affective expressions even when trained to display particular and restricted affects, one might question the reliability of the training technique. However, the training resulted in good overall displays of emotion. Each mother's overall display of each affect was easily identified by naive observers when the whole 15 s were played. There were no errors if one merely asked observers to identify which 15-s interval was happy, sad, or angry. In other words the gestalt of the expression was easily identified. Our coding was directed to a more specific question, however—did the infants match their own mother's particular mode of presenting the affects?

For the babies, across all conditions, nonmovement (29%) and interest (25%) were coded most often, followed by mouthings (17%), anger (14%), joy (13%), sadness (1%), fear (1%), and surprise (1%). All the babies except one showed some joy, with a range of 1% to 37%. One third of the babies showed some sadness, with a range of 1% to 9%. One baby did not show any anger, and the range for the others was 1% to 44%. All the babies showed some interest, with a range of 4% to 73%. No nonmovement seconds were coded for one baby, and the range for the

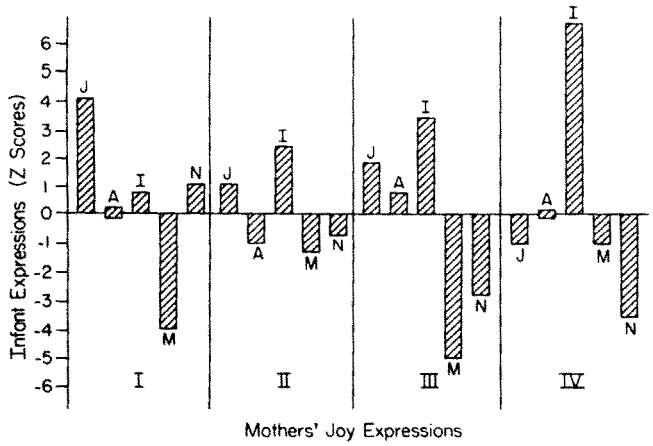

Figure 1. Joy: Infant responses (in *z* scores) to mothers' four sequential presentations of joy. Infant joy (J) decreases; interest (I) increases; mouthing (M) is inhibited; anger (A) is not different from baseline; and no movement (N) decreases.

Figure 2. Sad: Infant responses (in *z* scores) to mothers' four sequential presentations of sad. Infant mouthing (M) responses are increased across all presentations. Responses of joy (J), anger (A), interest (I), and no movement (N) are usually inhibited.

others was 1% to 65%. No mouthings were coded for one baby, and the range for the others was 3% to 48%.

Event Analyses of Babies' Facial Expression Responses to Mothers' Presentations

Sackett (1979) event analyses were performed separately with each of the following facial codes of the mothers as criteria: joy, anger, sadness, interest, and no movement. The facial-code responses of the infants that were criteria in these analyses were joy, anger, interest, mouthing, and nonmovement. The probabilities for the infants' sadness, surprise, and fear codes were not high enough to allow the use of the event analyses for these behaviors.

Sackett analyses were done separately for the four presentations of each emotion. The null hypothesis tested in each case was that the frequency of a particular infant facial expression to each type of maternal affect was significantly different from random responding. The figures show *z* scores that indicated deviation from the laboratory baseline. A positive *z* score indicated an increase in the behavior; a negative *z* score indicated a decrease. No significant score indicated that the behavior did not change from baseline expectation.

Joy

The babies displayed a highly significant amount of matching of their mothers' joy expressions on the first presentation, as shown in Figure 1. No significant matching occurred for the second and fourth presentations, but on the third presentation the frequency of the babies' joy responses was also significant in the predicted direction for matching. Generally, the infants showed some matching of the mothers' joy presentation and some tendency to inhibit "mouthing" responses. They significantly increased their interest displays and tended to show fewer no-movement facial expression responses to the later presentations.

Anger

The babies' anger responses to their mothers' anger presentations showed some significant matching in the predicted direction on the first, third, and fourth presentations, as shown in Figure 2. The amount of joy displayed by the babies was not significantly different from chance responding for all four presentations. Interest was significantly decreased, and no movement was significantly increased. One must note again that four infants were unable to complete this condition because the anger display induced intense crying in them; these four infants were not included in the analysis. The four infants included may

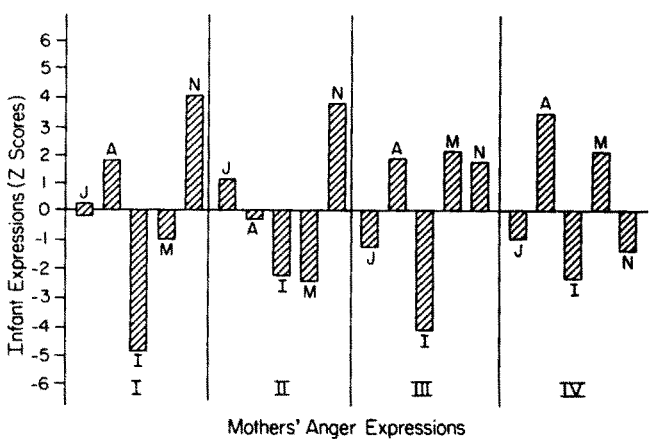

Figure 3. Anger: Infant responses (in *z* scores) to mothers' four sequential presentations of anger. Interest (I) is generally inhibited. Anger (A) is increased in presentations I, III, and IV; no movement (N) decreases; joy (J) is not different from baseline; mouthings (M) are probably not different from baseline.

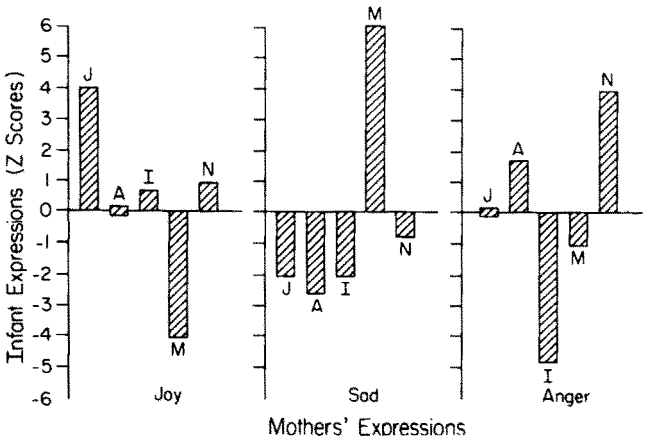

Figure 4. Affect summary: Infant response (in *z* scores) to mothers' first presentations of joy (JOY), sad (SAD), anger (ANGER) are presented. The behavior responses of the infants are different in each case. Infant joy (J) is increased only to mothers joy; infant mouthings (M) are increased only to mother sad; and infant anger (A) and no movement (N) are increased only to mother anger. Interest (I) is inhibited principally to mother anger; mouthing (M) is inhibited principally to mother joy; and most responses are inhibited to mother sad.

be somewhat unusual in their response to the anger display because they did not cry.

Sadness

As noted earlier, the babies' sad responses to their mothers' sad expressions were too infrequent to be tested for matching. As indicated in Figure 3 the babies' "mouthing" responses were consistently greater than chance for all four sad presentations, and anger was significantly decreased. Joy occurred infrequently on the first and second presentations but was significantly increased for the fourth presentation.

Interest

Because interest was not one of the emotions the mothers were instructed to present, matching by the babies for this affect was not predicted. Tone of voice may have been more frequently inconsistent with the mothers' interest expressions than for the other expressions because the mothers only talked about being happy, sad, and mad. In any case, anger was significantly decreased for interest presentation; other responses tended to be close to baseline.

Summary

As comparison of the figures has demonstrated, the infants' responses differed according to the mother's presentation. For quick comparison, Figure 4 presents the infants' average behaviors (presented in *z* scores) in response to the mothers' first presentations of each affect. The infants different responses indicated that they clearly differentiated the maternal behaviors. They increased joy and interest behavior only in the mother joy condition. They increased "mouthing" behaviors only in the mother sad condition, having decreased "mouthing" in the mother joy condition. They increased both anger and "no movement" responses in the mother anger condition and decreased interest. They decreased anger responses in the mother sad condition. These effects were visible not only in composite data but also are represented in individual cases. For example, no baby smiled continuously throughout any segment of the anger or sad presentation. Nor was any baby who was continued in the study immune to the mother's smile, even after the repeated sad or angry presentations.

Event Analyses of Babies' Gaze Direction Responses

There were associations between emotional expression and gazing in the predicted directions. As Table 1 indicates, joy expressions were associated with forward gaze responses. The babies' anger expressions frequently occurred with a side gaze. Gazing down responses occurred often with "mouthing" movements. Because these behaviors were not presented by the mother, they could not be interpreted as part of specific matching behavior. Their consistent relation to the infant affective expression seemed to be indicative of an emotional state.

Analyses of Time Effects

The previous analyses indicated that some of the babies' responses varied according to the number of the segment within each set of mothers' expressions. In addition to four segments per set there were also three sets of expressions. A correlational analysis was used to test time-in-the-study effects.

The babies' joy expressions decreased ($r = .38$, $p < .02$) over time in the study, but the frequencies of the other affect codes were not related to time. Thus, it appeared that the time context of the mothers' presentations affected only one of the babies' responses. Correlations of the number of seconds coded for the mothers' expressions and time were not significant (r ranged from $-.06$ to $.14$) indicating that the time effect was not due to variations in the mothers' facial expressions. However, note that infants dropped from the study were all in the "anger first" condition. This suggests that the infants remaining were less responsive or had a better recovery. In some cases, then, order effects might be highly visible.

Table 1
Results of Lag Analyses of Infants' Gaze Direction Responses Associated With Their Emotional Expressions

	Infants' gaze direction responses		
Criterion expressions	Forward	Side	Down
	z	*z*	*z*
Joy	7.33*	−8.00*	−3.00**
Anger	−1.33	4.50***	−2.50****
Interest	1.00	−1.00	.00
Mouthing	−.50	−1.50	5.00*
No movement	−5.00*	3.00**	4.00*****

* $p < .000001$. ** $p < .01$. *** $p < .00001$. **** $p < .02$. ***** $p < .0001$. (All of these probabilities are for two-tailed tests.)

Mothers' Vocal Presentations

Joy vocal expressions were rated most accurate. Of them, 89% were correctly identified by voice alone. Sadness was identified by voice alone 77% of the time, and anger was identified 59% of the time. There were, however, interpretation problems with these ratings because the raters only made a very gross estimate of whether the voice sounded happy, sad, or mad, and the taped sounds were distorted by the frequent erasures of words that were specific to the affect presented. The raters heard only "I'm so _____, I'm so _____, and so forth. Nevertheless these rating results suggested that there was appropriate information about the affect condition available from the vocal expression as well as the facial expression.

Second-by-second correlations between the facial expression and vocal expression were positive but not impressive. Over all seconds the correlation was .30 ($p < .001$). It was highest for joy ($r = .32, p < .02$), then for sad ($r = .24, p < .05$), but not significant for anger ($r = .14$). These correlations indicated that there was some tendency for mothers to present correct facial and vocal expressions simultaneously, but this was significant only for the joy and sadness presentations. As noted, the vocal ratings were a very gross measure of accuracy of the vocal expression, and one should note that a second-by-second match is a very stringent requirement of simultaneity.

Noncontingency of the Mothers' Presentations

The mothers were instructed not to respond to their babies' expressions. Correlational analyses to test for associations between the number of facial movement and affect changes for the babies and the mothers suggested that the mothers did not react to their babies' facial behaviors. Only 4 out of 20 correlations reached significance, and all four were negative. These results indicated that the mothers were able to follow the instructions.

Discussion

The results of this study support three major conclusions: First, by 10 weeks of age, infants respond differently to three maternal affect expressions when the presentation is simultaneously facial and vocal—joy, anger, and sadness. Second, these infants can match or mirror joy and anger expressions. Third, the infants' matching responses to the maternal affects are only part of complex but predictable behavioral patterns that seem to indicate meaningful affect states and possibly self-regulation in the infants.

The finding that infants discriminated three maternal affect expressions at the age of 10 weeks lowers the known age at which affect discriminations can be made. Previous studies have shown that older infants reliably discriminate a number of facial expressions (e.g., Barrera & Maurer, 1981; LaBarbera et al., 1976; Oster & Ewy, unpublished study, cited in Oster, 1981; Wilcox & Clayton, 1968; Young-Brown, Rosenfeld, & Horowitz, 1977). The expressions used, the type of presentation (film, color slides, achromatic slides, live presentations), the ages of the infants, and the response measures have varied widely in these studies. Overall, it has been clear that by 6 months most infants can discriminate still, posed versions of many facial expressions and preferentially look at happy poses over sad, neutral, or angry poses. Our results with much younger subjects indicate that they can discriminate several expressions if one uses live, familiar models and uses both facial and vocal cues. Whether facial or vocal cues alone would be sufficient during the second month is not determined in this study. The question of the separate effects of face and voice on the infants' responses to the emotion presentations remains a task for further research. It may be difficult to design a presentation that separates face and voice and does not violate the affordance of the affective presentation.

The matching of certain expressions has been demonstrated in a variety of studies. For example, the matching of certain facial movements such as tongue thrusting has been demonstrated even in neonates (Field, Woodson, Greenberg, & Cohen, 1982; Meltzoff & Moore, 1977; 1983). The matching of varied affect expressions at the age of 10 weeks has not explicitly been demonstrated previously. Although we demonstrated some matching of behaviors, the infants' behaviors during the emotion expression sessions indicated that more than simple matching occurred.

The infants' responses to the mothers' happy expressions represented a change in infants' affect state, rather than simple imitation. For example, the infants initially reacted to their mothers' joy presentations by reflecting the joyful expression of the mother. Over the four presentations, the infants became increasingly expressive of interest in the still positive interaction and less expressive of joy. Thus the induced state was one of interest or excitement. This state did not occur with high frequency during any of the other presentations. For this reason, it seemed that the happy expression of the mother, especially when it was not contingent, produced an interested state, although the initial infant response was to match or mirror the mother's expression.

There was a marked contrast between the joy expression responses and the anger expression responses showing that the response to the joy expression was not simply a response to a novel or changing stimulus or a nondifferentiating response to any expressive face. Notably, all the infants who did not complete the experimental procedure were in the condition of anger first (except for equipment failure). This anger presentation was so noxious to the infants removed from the study that they cried and had to be removed from the testing room for soothing. Obviously, when the mothers' expression was angry, infant expressions of interest were significantly decreased. The increased expressions of anger by the infants over the four presentations of their mothers' anger displays could be interpreted as a sign of increasing anger induced in the infants when the mothers continued with an angry display. The significant increase in "no movement" during the anger presentations also indicated a state change. It was possible that this was a genuine freezing and fearful behavior on the part of the infants in response to the maternal anger display. Anger and no movement facial expressions were typical responses to mothers' angry expressions. As in the other conditions, vocal responses such as crying were brief and rare except in those cases when the infants were removed from the study. It may be that those infants remaining in the study were able to self-regulate or modulate their expressions.

The infants' responses to the maternal sad expression also demonstrated a change in infant state. In this condition the infants' did not match the maternal sad expression. The infants instead responded with a "mouthing" behavior that consisted of mouth manipulations including lip and tongue sucking and pushing the lips in and out. This behavior did not occur frequently under the other conditions. The infants' mouthing behaviors in response to the sad expressions could be seen as self-soothing. In this they would be consistent with data that demonstrated "tongueing" as an early response to distressing expression (Aronson & Roseblum, 1971).

The congruence of facial expression and gaze behavior also supported the prediction of an induced affect state rather than expression matching. Mothers did not combine their facial expression with appropriate gaze and head-turn behavior because they were instructed to face the infant directly. The infants, however, faced forward consistently only during the joy presentation. They looked towards the side frequently during the angry presentation. This was probably an avoidant behavior. During the sad presentation the infants tended to gaze down, a congruent behavior for sadness. The gazing behavior may be part of an affective behavior pattern. On the other hand it may be specific to display instances in which the affective behavior is being self-regulated.

Several predictions about infants' ability to respond to emotional expressions have been proposed. The results of this study only support strongly the predictions that assume some capacity for young infants to respond differentially to the affordances of discrete emotional expressions. Infants cannot be described as responding to all faces with a smile (e.g., Ahrens, 1954; Buhler & Hetzer, 1928; Spitz & Wolf, 1946), nor can they be described as responding to changing affective expressions only as to novel objects (e.g., Kagan, 1974; McCall & McGhee, 1977). The infants respond as if the presented emotional expression contains meaningful information (e.g., Hoffman, 1978; Izard, 1977, 1979a; Tomkins, 1962) leading to an emotional expression and an emotional state in the infant. We are calling this response of the infant the *induced affect*.

In our opinion the induced-affect hypothesis provides the most reasonable explanation for infant matching of adult facial expressions of emotion. The mothers' expressions seem to have caused an emotional experience in the infants corresponding to the expression presented. The infants' change in emotional state led to the generation of other emotional responses that also function to control and regulate the interaction for the infant and the caregiver (Stern, 1985; Tronick, Ricks, & Cohn, 1982) including the provision of a means (facial expression) of signaling to the mother.

In summary, the major thrust of the present study was its investigation of young infants' responses to adult expressions of emotion. The results indicated that 10-week-old infants not only could match certain of their mothers' affect expressions but also responded in meaningful patterns to specific emotional expressions. If young infants can respond to emotional expression, then the possibilities for regulating or socializing emotion with emotional expression exist even in the early weeks of life. Because Malatesta and Haviland (1982) have demonstrated that mothers respond rapidly to changes in infants' facial expressions, a powerful system for the socialization of expression is present. Mothers need not only respond to infant expression with simple reinforcement, but may indeed control with their own expressions. This principle underlies the concept of "social referencing" as well (Campos & Stenberg, 1981).

The infants' behavior cannot be explained by theories that predict nonspecific responses to emotional expressions, because the infants' responses to joy, sadness, and anger were significantly different. The results may only be explained or described by theories that predict differential emotional response. We suggest that future research on infant–adult facial expression matching and debate about the mechanisms responsible for it would benefit from the use of an approach similar to that used in this study; that is, a focus on the social and emotional interaction context of such matching responses.

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